AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims

1. (Previously Presented) A graphics processing method, comprising:

defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion;

processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags, wherein the step of processing pixels includes:

processing a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags; and

depending on the geometry of the primitive, processing pixels in a second tile of the row of tiles responsive to the occlusion flags and then returning to the first tile to process additional pixels in the first tile responsive to the occlusion flags;

wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles, and wherein the step of setting occlusion flags includes:

determining a maximum depth value for the graphics primitive within a tile;

comparing the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache; and

setting the occlusion flag for the tile responsive to the comparison; and

utilizing results of the graphics processing to display enhanced graphics on an electronic display.

2. (Canceled)

3. (Previously Presented) The method according to claim 1, wherein processing pixels comprises processing rows of pixels in the row of tiles using a zig-zag traversal algorithm.

4. (Canceled)

5. (Previously Presented) The method according to claim 1, further comprising:

establishing a depth buffer configured to store respective occlusion threshold depth values for respective pixels of the graphics display field; and

wherein setting the occlusion flags comprises setting an occlusion flag for a tile to indicate non-occlusion; and

wherein processing pixels comprises:

detecting that the tile has a occlusion flag indicating non-occlusion; and

responsively processing a pixel for the graphics primitive in the tile without retrieving an occlusion threshold depth value for the pixel from the depth buffer.

6. (Previously Presented) The method according to claim 5, further comprising establishing a color buffer configured to store respective color values for respective ones of the pixels of the graphics display field, and wherein responsively processing a pixel for the graphics primitive in the tile without retrieving an occlusion threshold depth value for the pixel from the depth buffer comprises responsively storing a color value and a depth value for the graphics primitive for the pixel in the color buffer and the depth buffer, respectively.

7. (Previously Presented) The method according to claim 6, wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion

threshold depth values for the respective tiles of the row of tiles, and wherein the method further comprises:

determining a depth value for the graphics primitive for the pixel;

comparing the determined depth value for the graphics primitive for the pixel to the occlusion threshold depth value for the tile in the tile occlusion information cache; and

updating the occlusion threshold depth value for the tile in the tile occlusion information threshold cache to the determined depth value for the graphics primitive for the pixel responsive to the comparison.

8. (Previously Presented) The method according to claim 7:

wherein setting occlusion flags comprises setting an occlusion flag for a tile to indicate non-occlusion, and wherein processing pixels is preceded by:

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all of the rows of tiles; and

loading the tile occlusion information cache with occlusion threshold depth values from the aggregate time occlusion information memory; and

wherein updating the occlusion threshold depth value for the tile in the tile occlusion information threshold cache is followed by updating threshold occlusion depth values in the aggregate tile occlusion information memory from the tile occlusion information cache.

9. (Previously Presented) A graphics processing method, comprising:

defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion;

processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags;

establishing a depth buffer configured to store respective occlusion threshold depth values for respective pixels of the graphics display field; and

wherein setting occlusion flags comprises setting the occlusion flag for a tile to indicate possible occlusion; and

wherein processing pixels comprises:

detecting that the tile has an occlusion flag indicating possible occlusion; and

comparing a depth value for the graphics primitive for a pixel in the tile to an occlusion threshold depth value for the pixel in the depth buffer responsive to detecting that the tile has an occlusion flag indicating possible occlusion;

processing the pixel responsive to the comparison; and

updating the occlusion threshold depth value for the tile in the tile occlusion information cache responsive to the written z-value of the pixel; and

utilizing results of the graphics processing to display enhanced graphics on an electronic display.

10. (Previously Presented) The method according to claim 9, further comprising establishing a color buffer configured to store respective color values for respective ones of the pixels of the graphics display field, and wherein processing the pixel comprises storing a color value and a depth value in the color buffer and the depth buffer, respectively, if the comparison of the depth value for the graphics primitive for the pixel in the tile to the occlusion threshold depth value for the pixel in the depth buffer indicates non-occlusion and updating the occlusion threshold depth value for the tile in the tile occlusion information cache responsive to the written z-value of the pixel.

11. (Previously Presented) A graphics processing method, comprising:

defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, wherein the occlusion flags are stored in a tile occlusion

information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles;

processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags, said processing step including:

processing a first row of pixels responsive to the tile occlusion information cache, wherein processing a first row of pixels comprises setting occlusion and status flags for at least one tile in the first row of tiles to indicate that occlusion status of the at least one tile has been determined;

determining whether a second row of pixels is in the first row of tiles; and

processing a second row of pixels using information in the tile occlusion cache gained from the first row of pixels if the second row of pixels is in the first row of tiles; and

utilizing results of the graphics processing to display enhanced graphics on an electronic display.

12. (Previously Presented) A graphics processing method, comprising:

defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles;

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all tiles in all rows of tiles;

setting the occlusion and status flags in the tile occlusion information cache to predetermined values;

storing occlusion threshold depth values for the first row of tiles from the aggregate tile occlusion information memory in the tile occlusion information cache;

processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags, said processing step including:

processing a first row of pixels responsive to the tile occlusion information cache, wherein processing a first row of pixels comprises setting occlusion and status flags for at least one tile in the first row of tiles to indicate that occlusion status of the at least one tile has been determined;

determining whether a second row of pixels is in the first row of tiles; and

processing a second row of pixels using information in the tile occlusion cache gained from the first row of pixels if the second row of pixels is in the first row of tiles; and

utilizing results of the graphics processing to display enhanced graphics on an electronic display.

13. (Previously Presented) A graphics processing method, comprising:

defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles, and wherein the method further comprises:

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all tiles of the rows of tiles;

processing a first row of pixels responsive to the tile occlusion information cache, wherein processing a first row of pixels comprises setting occlusion flags and status

flags for a first row of tiles having pixels in the first row of pixels to indicate that at least one occlusion status of at least one tile in the first row has been determined;

determining whether a second row of pixels is in the first row of tiles;

responsive to determining that the second row of pixels is in a second row of tiles, writing back the occlusion threshold depth values from the tile occlusion information cache to the aggregate tile occlusion information in the tile occlusion information cache, loading occlusion threshold depth values into the tile occlusion information cache with corresponding occlusion threshold depth values for the second row of tiles from the aggregate tile occlusion information memory, and processing the second row of pixels using the updated tile occlusion cache; and

utilizing results of the graphics processing to display enhanced graphics on an electronic display.

14. (Previously Presented) The method according to claim 13, wherein determining whether a second row of pixels is in the first row of tiles is followed by updating occlusion threshold depth values for the first row of tiles in the aggregate tile occlusion information memory with occlusion threshold depth values from the tile occlusion cache responsive to determining that the second row of pixels is in a second row of tiles.

15. (Previously Presented) An apparatus, comprising:

a display; and

a graphics processor coupled to the display for providing enhanced graphics to the display, said graphics processor comprising:

means for defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

means for setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion;

means for processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags, wherein the means for processing pixels includes:

means for processing a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags; and

means for processing, dependent upon the geometry of the primitive, pixels in a second tile of the row of tiles responsive to the occlusion flags and then returning to the first tile to process additional pixels in the first tile responsive to the occlusion flags;

a tile occlusion information cache for storing the occlusion flags, the tile occlusion information cache being configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles; and

wherein the means for setting occlusion flags includes:

means for determining a maximum depth value for the graphics primitive within a tile;

means for comparing the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache; and

means for setting the occlusion flag for the tile responsive to the comparison.

16. (Canceled)

17. (Previously Presented) The apparatus according to claim 15, wherein the graphics processor is operative to process rows of pixels in the row of tiles using a zig-zag traversal algorithm.

18. (Canceled)

19. (Previously Presented) The apparatus according to claim 15, wherein the display and the graphics processor are housed in a portable electronic device.

20. (Currently Amended) An apparatus, comprising:

a display; and

a graphics processor coupled to the display for providing enhanced graphics to the display, said graphics processor comprising:

means for dividing a graphics display field into a row of tiles, the row of tiles including at least two rows of pixels;

means for determining a maximum depth value for a graphic primitive within a given tile;

means for determining a minimum depth value for ~~pixels in~~ said given tile;

means for determining whether the minimum depth value for the given tile exceeds the maximum depth value for the graphic primitive;

means for establishing a tile occlusion information cache configured to store respective occlusion flags for respective tiles of a row of tiles and respective minimum depth values for the respective tiles of the row of tiles;

means for comparing the maximum depth value for the graphic primitive to a minimum depth value for the given tile stored in the tile occlusion information cache;

means for setting an occlusion flag for the given tile to indicate that the graphics primitive is not occluded in the given tile upon determining that the minimum depth value for the given tile exceeds the maximum depth value for the graphics primitive; and

means for processing pixels for the graphics primitive in a row-by-row fashion, said processing step including processing a pixel within the given tile for the graphics primitive responsive to the setting of the occlusion flag.

21. (Previously Presented) The apparatus according to claim 20, wherein the graphics processor is operative to maintain a depth buffer configured to store respective occlusion threshold depth values for respective pixels of a graphics display field of the display and to process the pixel without retrieving an occlusion threshold depth value from the depth buffer.

22. (Canceled)

23. (Previously Presented) A computer program product comprising program code embodied in a computer-readable medium, the program code comprising program code configured to cause a graphics processor to:

define a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;

set occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion;

process pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags, wherein the pixel processing includes:

processing a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags; and

depending on the geometry of the primitive, processing pixels in a second tile of the row of tiles responsive to the occlusion flags and then returning to the first tile to process additional pixels in the first tile responsive to the occlusion flags;

wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles, and wherein the setting of occlusion flags includes:

determining a maximum depth value for the graphics primitive within a tile;

comparing the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache; and

setting the occlusion flag for the tile responsive to the comparison; and

wherein the graphics processor utilizes results of the graphics processing to display enhanced graphics on an electronic display.

24. (Canceled)

25. (Previously Presented) The computer program product according to claim 23, wherein the program code is further configured to process rows of pixels in the row of tiles using a zig-zag traversal algorithm.

26. (Previously Presented) A computer program product comprising program code embodied in a computer-readable medium, the program code comprising program code configured to cause a graphics processor to:

divide a graphics display field into a row of tiles, the row of tiles including at least two rows of pixels;

determine a maximum depth value for a graphic primitive within a given tile;

determine a minimum depth value for pixels in said given tile;

determine whether the minimum depth value for the given tile exceeds the maximum depth value for the graphic primitive;

establish a tile occlusion information cache configured to store respective occlusion flags for respective tiles of a row of tiles and respective minimum depth values for the respective tiles of the row of tiles;

compare the maximum depth value for the graphic primitive to a minimum depth value for the given tile stored in the tile occlusion information cache;

set an occlusion flag for the given tile to indicate that the graphics primitive is not occluded in the given tile upon determining that the minimum depth value for the given tile exceeds the maximum depth value for the graphics primitive;

process pixels for the graphics primitive in a row-by-row fashion, said pixel processing including processing a pixel within the given tile for the graphics primitive responsive to the setting of the occlusion flag; and

utilize results of the graphics processing to display enhanced graphics on an electronic display.

27. (Previously Presented) The computer program product according to claim 26, wherein the program code is further configured to cause the graphics processor to maintain a depth buffer configured to store respective occlusion threshold depth values

for respective pixels of a graphics display field of the display and to process the pixel without retrieving an occlusion threshold depth value from the depth buffer.

28-30. (Canceled)

31. (Previously Presented) The method according to claim 41, wherein processing a pixel includes rendering the pixel without comparing a depth value thereof to an occlusion threshold value responsive to determining that the occlusion flag setting indicates that the graphics primitive is not occluded in the tile.

32. (Previously Presented) The method according to claim 41, wherein the step of determining a maximum depth value includes determining a depth greater than or equal to all possible depth values that the graphics primitive may have in a tile.

33. (Previously Presented) The method according to Claim 32, wherein the step of determining a maximum depth value includes determining a maximum depth of vertices of the graphics primitive.

34. (Previously Presented) The method according to Claim 32, wherein the step of determining a maximum depth value includes determining a maximum depth of a plane of the graphics primitive in the tile.

35-36. (Canceled)

37. (Previously Presented) The method according to claim 41, wherein processing pixels for the graphics primitive in a row-by-row fashion includes processing the graphics primitive using a zig-zag traversal algorithm.

38. (Previously Presented) The method according to claim 41, further comprising:

processing a first portion of the given tile for the graphics primitive;

processing at least a portion of a second tile for the graphics primitive; and

subsequently processing a second portion of the given tile for the graphics primitive.

39-40. (Canceled)

41. (Currently Amended) A graphics processing method, comprising:

dividing a graphics display field into a row of tiles, the row of tiles including at least two rows of pixels;

determining a maximum depth value for a graphic primitive within a given tile;

determining a minimum depth value for ~~pixels in~~ said given tile;

determining whether the minimum depth value for the given tile exceeds the maximum depth value for the graphic primitive;

establishing a tile occlusion information cache configured to store respective occlusion flags for respective tiles of a row of tiles and respective minimum depth values for the respective tiles of the row of tiles;

comparing the maximum depth value for the graphic primitive to a minimum depth value for the given tile stored in the tile occlusion information cache;

setting an occlusion flag for the given tile to indicate that the graphics primitive is not occluded in the given tile upon determining that the minimum depth value for the given tile exceeds the maximum depth value for the graphics primitive;

processing pixels for the graphics primitive in a row-by-row fashion, said processing step including processing a pixel within the given tile for the graphics primitive responsive to the setting of the occlusion flag; and

utilizing results of the graphics processing to display enhanced graphics on an electronic display.